DOCUMENT RESUME

ED 269 252 SE 046 570

AUTHOR Blank, Rolf K.
TITLE Teacher Quality in Science and Mathematics Education: Recommendations for Research from a National Research Council Conference.
INSTITUTION National Academy of Sciences - National Research Council, Washington, DC. Committee on Research in Mathematics, Science, and Technology Education.
PUB DATE [86]
NOTE 11p.; Paper presented at the Annual Meeting of the American Educational Research Association (70th, San Francisco, CA, April 16-20, 1986).
PUB TYPE Speeches/Conference Papers (150) -- Information Analyses (070)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS Elementary Secondary Education; Higher Education; *Mathematics Education; Performance Factors; *Research Needs; *Science Education; *Teacher Education; *Teacher Effectiveness; *Teacher Recruitment

ABSTRACT

Thirty-five experts from several fields of research participated in a discussion to explore whether future research is needed on issues related to teacher quality, what kinds of research are needed, and in particular, what issues could best be addressed by a National Research Council study of teacher quality in elementary/secondary science and mathematics. Findings and recommendations that define needed research on teacher quality (which has direct relevance to policies concerning teacher training, development, and selection) are grouped into the following six categories: (1) studies to assist recruitment and selection of teachers; (2) studies on education of teachers: subject matter proficiency; (3) studies on evaluation of teachers development of teaching skills; (4) studies on effects of teaching practices; (5) studies on conditions fostering quality teaching; and (6) studies on societal issues related to teacher quality in science and mathematics. Two recommendations (related to the first category) include investigating effects of state and local policies which set new standards for entry into the teaching profession and analyses of the relationship between teacher supply and demand issues and quality issues, such as the effect of non-certified and "out-of-field" teachers on quality, and implications of differing criteria of "qualified." (JN)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

☑ This document has been reproduced as received from the person or organization originating it.

☐ Minor changes have been made to improve reproduction quality.

• Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

ED269252

TEACHER QUALITY IN SCIENCE AND MATHEMATICS EDUCATION: RECOMMENDATIONS FOR RESEARCH FROM A NATIONAL RESEARCH COUNCIL CONFERENCE

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY

Rolf K. Blank

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

Rolf K. Blank

Committee on Research in Mathematics, Science, and Technology Education
National Research Council
2101 Constitution Avenue, N.W.
Washington, D.C. 20418

Presentation at the annual meeting of the American Educational Research Association, San Francisco, April 1986.

The views expressed herein do not necessarily reflect the position of the National Research Council, and no endorsement should be inferred.

SE 046 570

TEACHER QUALITY IN SCIENCE AND MATHEMATICS EDUCATION: RECOMMENDATIONS FOR RESEARCH FROM A NATIONAL RESEARCH COUNCIL CONFERENCE

INTRODUCTION

For the last several years, improving the quality of teachers in the nation's schools has emerged as a major goal in education. Reform initiatives at all levels--federal, state, and local--have been proposed and implemented. For example, merit pay and differentiated salary levels have been advanced as strategies for attracting and retaining teachers of high quality. Written tests of teachers' knowledge of basic skills and subject areas have been initiated in 25 states. Several national commissions have recommended that prospective teachers receive more education in subject areas and better teacher training in general. Some states have raised certification standards for teachers, although at least one state has recently decreased the amount of formal teacher education necessary for certification. At the national and state levels, loan and scholarship programs have been authorized to encourage entrance of qualified individuals into teacher education programs.

It is unclear, however, whether these initiatives are based on a common definition of teacher quality or adequate knowledge about the conditions that produce quality teaching. To assess what is known about teacher quality in science and mathematics education and to what extent such knowledge supports the appropriateness of various initiatives, the Committee on Research in Mathematics, Science, and Technology Education of the National Research Council (NRC) convened a small conference on June 27-28, 1985.

Marshall Smith of the University of Wisconsin was asked to chair the conference, and he was instrumental in planning the agenda together with the committee and staff. Relevant research on the broad question of teacher quality in science and mathematics was reviewed in a background paper for the conference (Blank and Raizen, 1985).

Three central questions were identified as the basis for presentations and discussion:

1. How should teacher quality be defined for science and mathematics education, at both the elementary and secondary levels?

2. What are the implications of several models for improving teacher quality in recent reform proposals and initiatives?

3. What is the state of existing research knowledge on teacher quality?

Thirty-five experts from several fields of research and teaching, including natural sciences, mathematics, social sciences, elementary and secondary education, and public policy, were invited to participate in a discussion of these questions. The primary objectives of the conference were to explore whether further research is needed on issues related to teacher quality, what kinds of research are needed, and, in particular, what issues could best be addressed by an NRC study of teacher quality in science and mathematics.

CONFERENCE FINDINGS AND RECOMMENDATIONS

For the purposes of this symposium, I have outlined the conference findings and recommendations that define needed research on teacher quality. The research that is recommended has direct relevance

to policies concerning teacher training, development, and selection. The findings and recommendations are grouped into six categories which reflect the major directions for new research.

I. Studies to Assist Recruitment and Selection of Teachers

- o Existing research has focused on teacher characteristics that define a "qualified" teacher.
  - Wide variation in state requirements restrict use of certification as a qualifications measure.
  - Predominantly used measures of teacher qualifications are: academic ability, level of education, and years of experience. Studies of teacher effectiveness have tried to relate qualifications to outcome measures.
  - The measures of qualifications are too general to differentiate teachers as they perform in the classroom. Student achievement tests have limited validity in assessing effects of teaching.
- o Teacher competency tests have been developed in over 30 states to screen teacher applicants. Scores may be useful as a basic measure of teacher qualifications, but if used as a necessary condition for hiring, the ability of schools to select teachers on other criteria will be reduced -- criteria such as initiative, creativity, or ability with children.
- o A major policy issue related to teacher quality is whether to try to change the characteristics of the teachers in the pool of applicants, or to try to improve the capacity and skills of the existing applicant pool.
  - Possibly, research should be aimed at improving measurement of teacher performance on the job, and factors affecting performance that can be manipulated through education policies, e.g., teacher education, staff development, classroom skills, and lesson planning; schools would then assume they will receive applicants with a range of qualities that are harder to change, e.g., academic ability, creativity, leadership, or personality.

Recommendations for research:

a) Effects of state and local policies which set new standards for entry to teaching profession.

b) Models to track and assess the long-term impacts of "screens" and "magnets" on teachers in the profession.

c) Analyses of the relationship between teacher supply and demand issues and quality issues, such as effect of non-certified and "out-of-field" teachers on quality, and implications of differing criteria of "qualified."

II. Studies on Education of Teachers--Subject Matter Proficiency

- o Existing studies that use measures of teacher knowledge of subject matter, such as level of education or number of credits in a subject area, do not show strong relationship to teaching effectiveness.

  Recommendations for research:

  a) Studies of subject matter knowledge employing representative samples of teachers, both elementary and secondary (e.g., Research Triangle/NSF survey).

  b) Analyses of the relationship between teachers' scores on subject area tests (some current state tests) and teaching effectiveness measures.

- o Many science teachers do not emphasize science as process or the development of higher-order skills, partly due to their own education in science. Some colleges and universities have "science for teachers" courses that do not include "doing science" or teaching teachers to "think as scientists."

  Recommendations for research:

  a) Descriptive studies of college and university teacher education programs in science and mathematics that teach higher-order skills and prepare new teachers with this approach.

- o There is a problem in many colleges and universities of a separation between teacher education curricula and subject area curricula (i.e., arts and sciences courses), both in content and form of instruction. As a result, some areas of importance in teaching are covered poorly, such as content of elementary or secondary curriculum in science, and pedagogical methods specific to subjects.

  Recommendations for research:

  a) Studies of the problems of collegiate education of teachers, particularly separation between education and arts and sciences curricula, and lack of interdisciplinary planning, research, and development.

b) Identification and description of alternative approaches to teacher education in science and mathematics for elementary and middle/junior level teachers, particularly those aimed at overcoming elementary teachers' fear of science and mathematics and programs designed to increase student motivation towards science and mathematics.

III. Studies on Education of Teachers--Development of Teaching Skills

- o There are a variety of approaches and areas of emphasis in the development of teaching skills, both in pre-service teacher education and continuing professional development.

- o Alternative approaches and emphases include: greater use of internships and apprenticeships for new teachers, increased application of research on cognitive processes, training in techniques of classroom management and planning use of time, and developing specific teaching methods for subject matter and concepts.

Recommendations for research:

a) Assessment of the effects of alternative models and approaches in development of teaching skills.

b) Relationship between teacher education, teaching techniques and approaches, and student attitudes/motivation toward subject matter.

IV. Studies on Effects of Teaching Practices

- o A considerable body of research has been developed in the broad area of teaching practices that are effective in raising student academic performance. This research has helped to focus teacher education and policies for teacher evaluation and improvement, especially in analyzing observable teacher skills and behaviors and "active teaching" methods in the classroom. However, there are several areas of needed research.

Recommendations for research:

a) Improved methods for assessing student performance that reflect curriculum objectives--to help solve the "dependent variable problem" in research on teachers.

b) Development of improved instruments for direct assessment of teaching performance, such as observation and rating of teacher efforts to advance student understanding of essential concepts. Goal should be to reduce the use of indirect measures of teacher quality.

c) Studies of teacher effects with specific subjects, grades, and student groups, particularly elementary and middle school science and mathematics.
d) Analyses of reasons for teachers not using "active teaching" methods, i.e., "teachers not teaching."

V. Studies on Conditions Fostering Quality Teaching

There are several kinds of conditions beyond the individual teacher's attributes, preparation, and skills that may explain the quality of teaching.

- o National commissions, teacher unions, and education policy makers and analysts have recently advocated that professional standards for teachers be raised in order to ensure quality of education and improve the public's view of the capabilities of teachers.

- o Working conditions in schools have been frequently cited as an explanation for why trained teachers do not enter teaching and well-qualified teachers leave the profession. Low salaries, lack of autonomy and decision-making, poor facilities and equipment, and little opportunity for professional advancement are some of the conditions that may be related to poor quality of teaching.

- o Three recent trends in public education may inhibit the growth of teacher professionalism: a) greater interest in educational accountability and central management and control of schools, b) more "teacher-proof" curricula developed by states and school districts, and c) increased demand and short supply of new teachers.

Recommendations for research:

a) Assessment of the effects of raising professional standards on the teacher pool, and, in the long-term, on teacher quality (such as the plans for the new ED Center for Policy Research in Education).

b) Case studies of the relationship between district and school management and teacher professionalism, i.e., teacher autonomy, collegiality, improved knowledge and skills, etc.

c) Analyses of the career patterns of science and mathematics teachers and the effects of school conditions, along with other factors, in determining teaching careers.

VI. Studies on Societal Issues Related to Teacher Quality in Science and Mathematics

- Teacher quality in science and mathematics, and efforts to improve quality, may be a function of several long-range issues in the society and how they are addressed.

Recommendations for research:

a) Analyses of the costs of investments in improving teacher quality in science and mathematics, and policy studies of public support for the investments.

b) Assessments of the priority of science and mathematics education in the society and the role of public schools vs. other educational and non-educational institutions involved in science education.

c) Identification of the goals for student learning in science and mathematics, and translation of the goals into policies for teacher training and development, i.e., goals such as basic science literacy for citizenship vs. science and technology education for job preparation vs. pre-college science and mathematics preparation.

BIBLIOGRAPHY

Arons, Arnold B.
1983 Achieving wider scientific literacy. Daedalus 112(Spring):91-122.

Blank, Rolf K. and Raizen, Senta A.
1985 Background Paper for a Planning Conference on a Study of Teacher Quality in Science and Mathematics Education. National Research Council, Washington, D.C.

Brophy, Jere
1985 Teacher Effects. Institute for Research on Teaching, Michigan State University, East Lansing, MI.

Committee on National Statistics
1984 Report of the Planning Conference for a Study of Statistics on Supply and Demand for Precollege Science and Mathematics Teachers. Washington, D.C.: National Research Council.

Committee on Research in Mathematics, Science, and Technology Education
1985 Mathematics, Science, and Technology Education: A Research Agenda. National Research Council. Washington, D.C.: National Academy Press.

Darling-Hammond, Linda
1984 Beyond the Commission Reports: The Coming Crisis in Teaching. Washington, D.C.: The Rand Corporation.

Druva, Cynthia Ann and Anderson, Ronald D.
1983 Science teacher characteristics by teacher behavior and student outcome: a meta-analysis of research. Journal of Research in Science Teaching 20(5):467-479.

Feistritzer, C. E.
1984 The Making of a Teacher: A Report on Teacher Education and Certification. Washington, D.C.: National Center for Education Information.

Hanushek, Eric A.
1981 Throwing money at schools. Journal of Policy Analysis and Management 1(1):19-41.

Lortie, Dan C.
1975 Schoolteacher: A Sociological Study. Chicago: University of Chicago Press.

Murnane, Richard
1985 Do Effective Teachers Have Common Characteristics?: Interpreting the Quantitative Research Evidence. Presentation at the National Research Council Conference on Teacher Quality in Science and Mathematics, Washington, D.C., June 1985.

National Commission for Excellence in Teacher Education
1985 A Call for Change in Teacher Education. Washington, D.C.: American Association of Colleges for Teacher Education.

Raizen, Senta A., and Jones, Lyle V., eds.
1985 Indicators of Precollege Education in Science and Mathematics: A Preliminary Review. Washington, D.C.: National Academy Press.

Schlechty, Phillip C. and Vance, Victor S.
1983 Recruitment, selection, and retention: the shape of the teaching force. The Elementary School Journal 83(4):469-487.

Sykes, Gary
1983 Public policy and the problem of teacher quality. In Lee S. Schulman and Gary Sykes, eds., Handbook of Teaching and Policy. New York: Longman.